

# 1919: Ernest Rutherford Transmutes One Element into Another



Ernest Rutherford 1871-1937

Born in Brightwater, New Zealand

Graduate studies at the Cavendish Laboratory, University of Cambridge, UK

Chair of Physics at McGill and Manchester

Fellow of the Royal Society

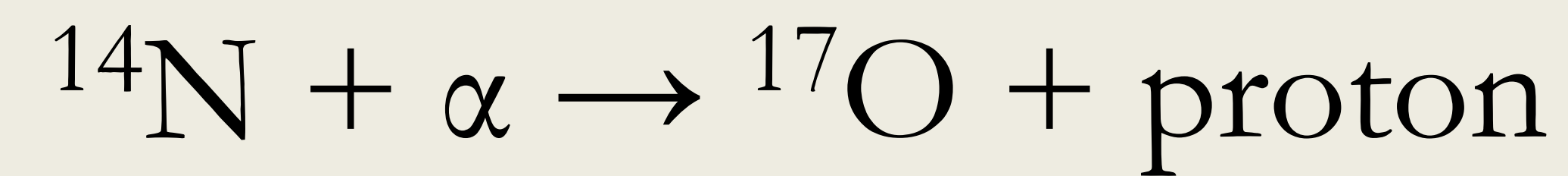
Nobel Prize in Chemistry (1908)

Quote: "All science is either physics or stamp collecting"



Device used to observe the first transmutation

## Experiment



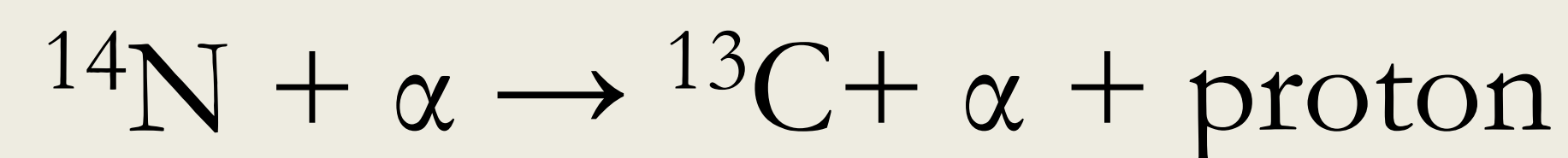
1914 – In an experiment, the source of alpha particles, Radium C ( $^{214}\text{Bismuth}$ ), appeared to give off hydrogen nuclei

1917 – Ernest believed he detected a lighter atom deflected by alpha particles.

1919 – The first results of Rutherford's alpha particle bombardment were published in April's edition of *Philosophical Magazine*.

First conjecture:

The alpha particles were hitting the nucleus and liberating a proton while leaving the alpha particle intact.

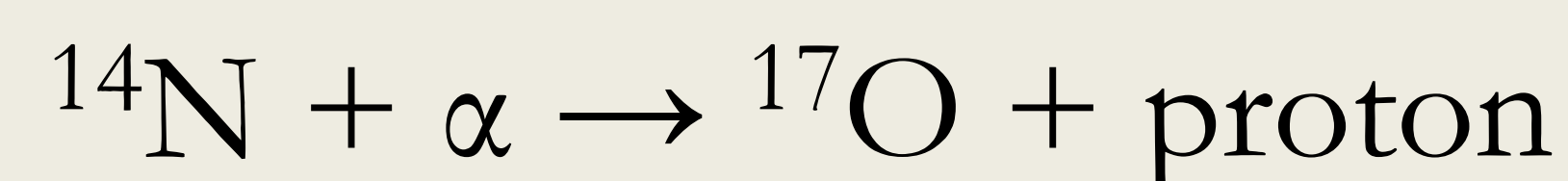


At the time, Rutherford believed that the alpha particle was a fundamental particle that could not be broken down.

1925 – Patrick Blackett used a cloud chamber to show that two trajectory tracks resulted in alpha particle bombardment with nitrogen.

Second conjecture:

The alpha particle was destroyed in a collision with the nitrogen nucleus.



Propositions:

1. A proton-electron like particle (neutron) could exist (found in 1932).
2. Certain isotopes could exist such as  $^3\text{He}$  (Tritium, found in 1934), and  $^2\text{H}$  (Deuteron, found in 1931).

## Merits

Natural transmutation:

All of the elements observed in nature have resulted from nuclear transmutation.

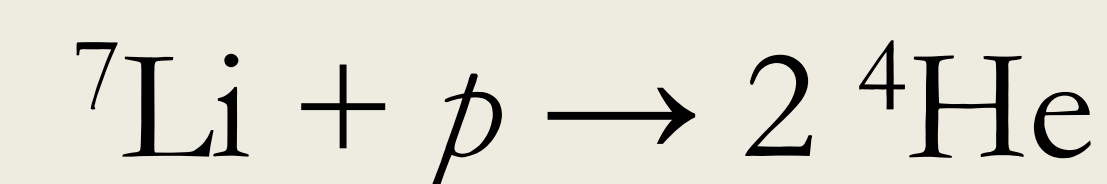
The Big Bang is believed to be the origin of hydrogen and a few lighter elements. The rest of the elements were formed in the core of stars.

Synthetic transmutation:

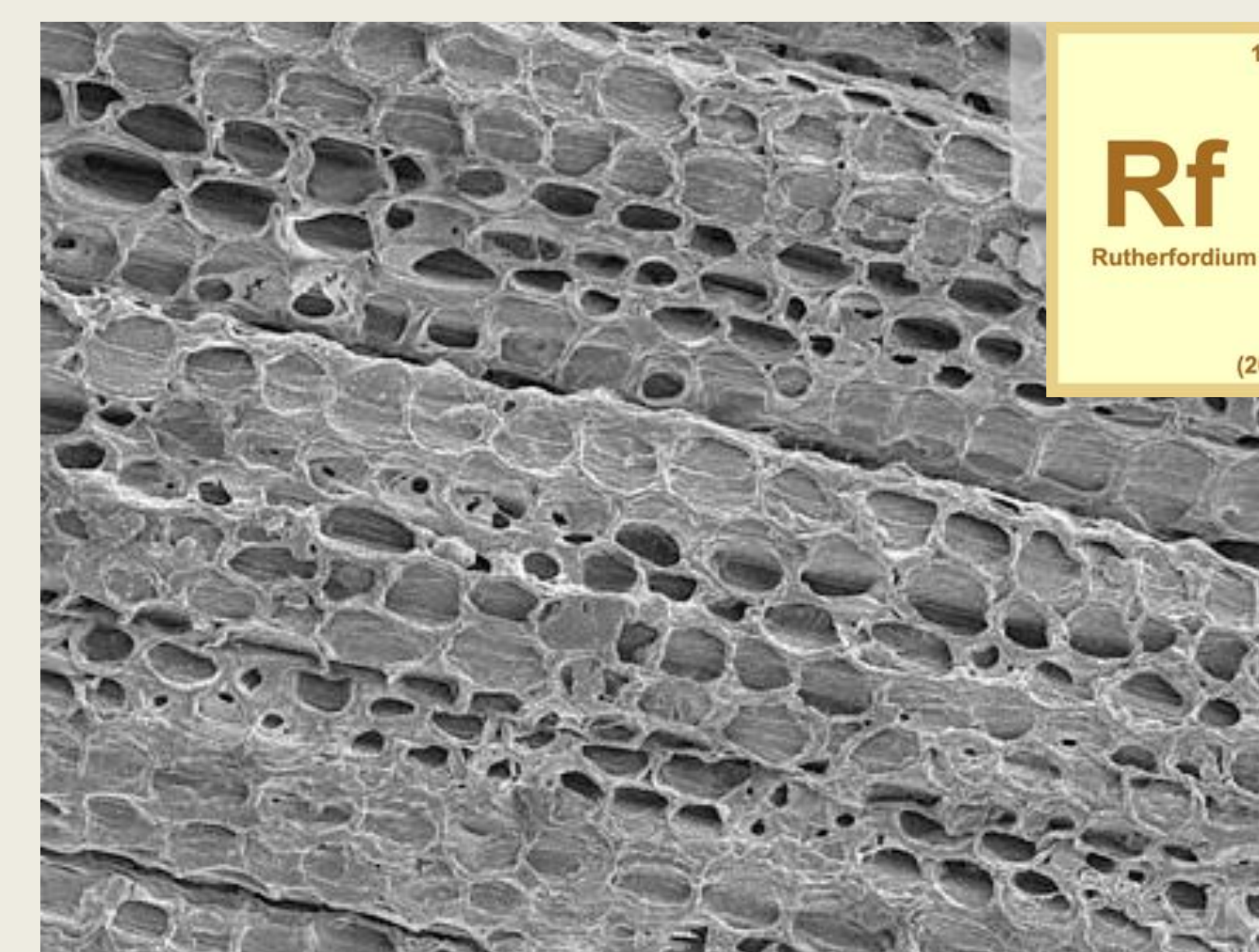
All elements with an atomic number greater than 98 don't occur naturally and are the result of transmutation.

Synthetic transmutation is considered to be a panacea for the mitigation of nuclear waste. Actinides have long half-lives typically exceeding 1,000 years. The transmuted products of actinides can have half-lives of less than 30 years.

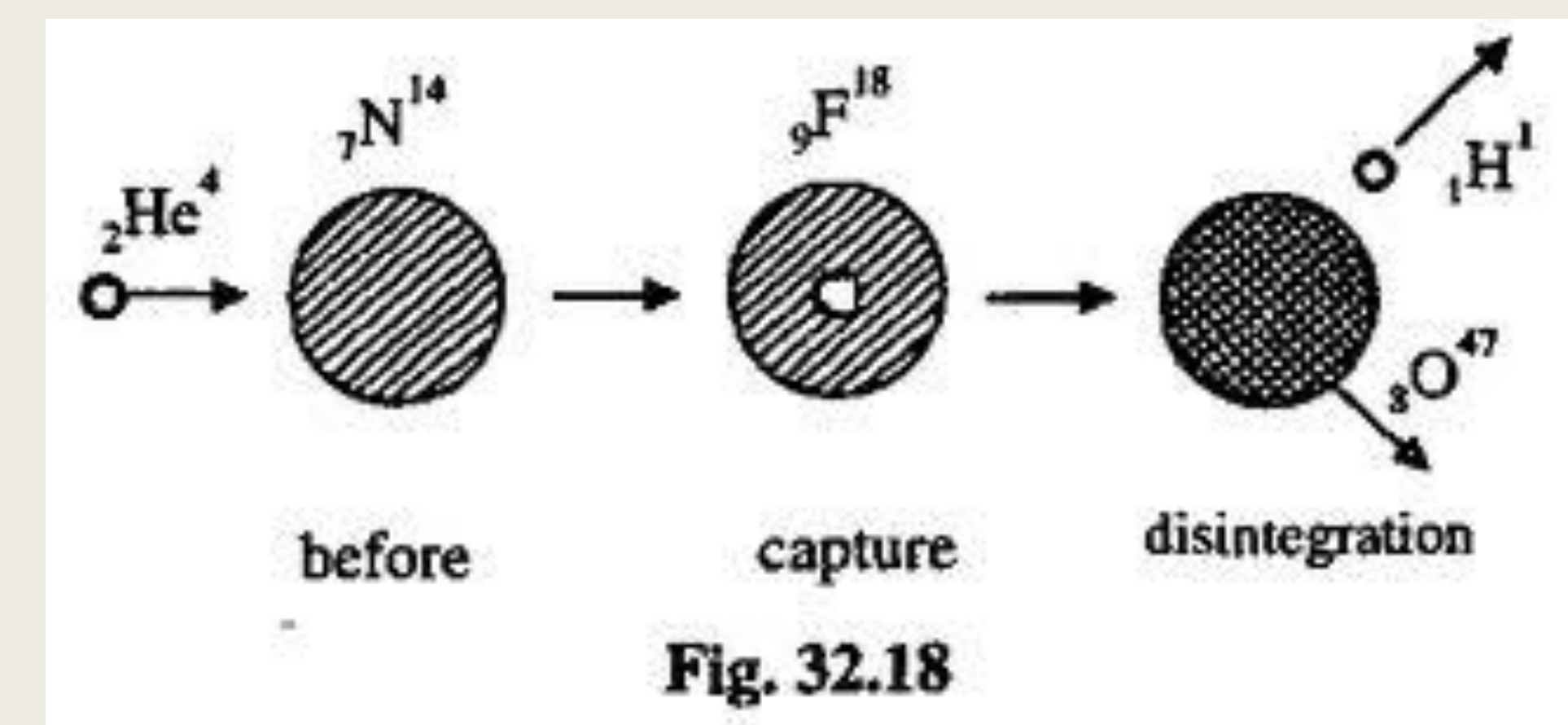
$E = mc^2$  :



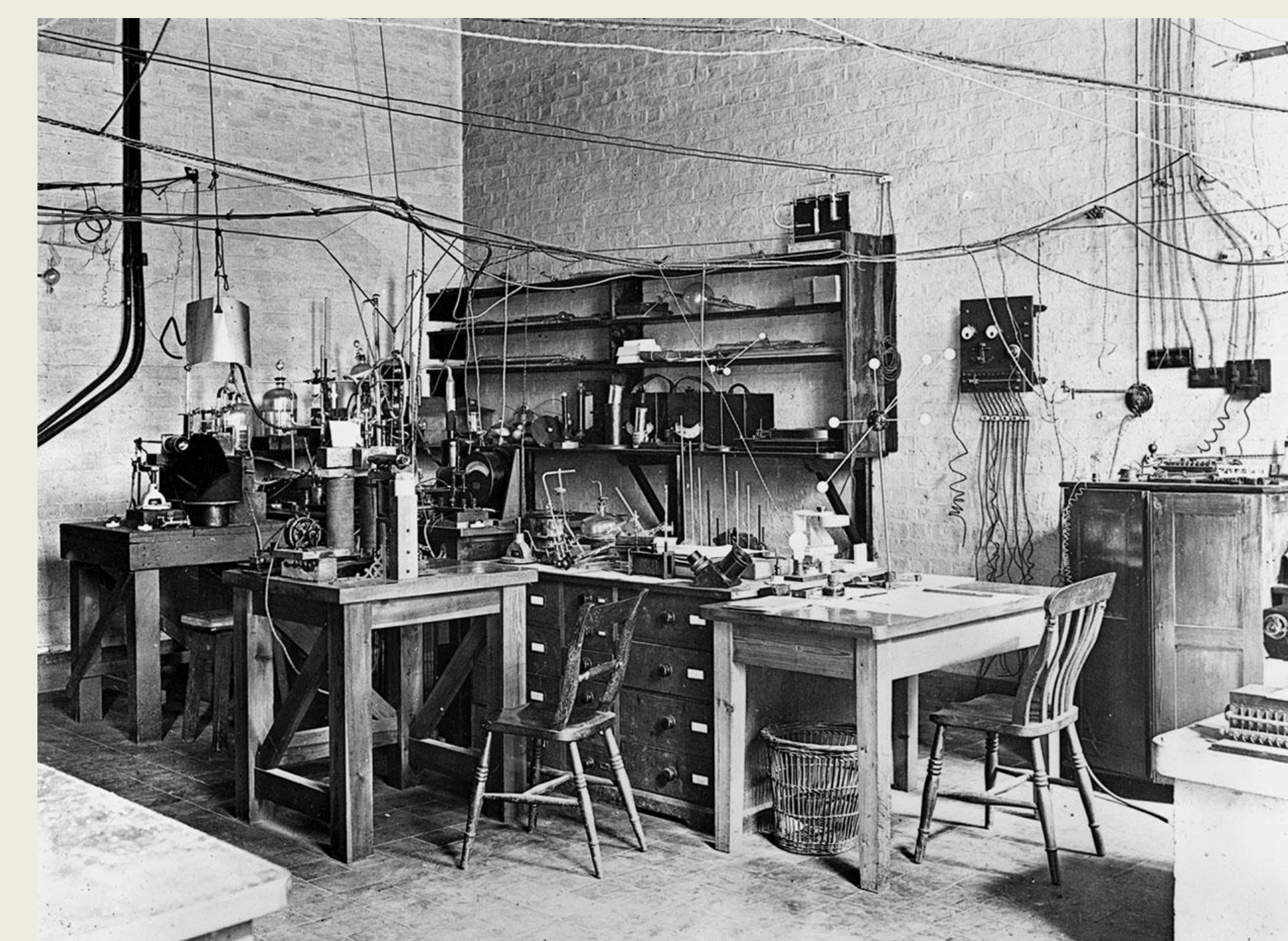
In 1932, the transmutation of a lithium atom and a proton into two alpha particles allowed Einstein's energy mass equivalence to be tested within a half of one percent.



Rutherfordium



Rutherford's depiction of the first transmutation



Rutherford's laboratory, University of Manchester